Status of the HIRDLS HNO_3 Data Product

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+ MLS Science Team

+ ACE Science Team

+ FIRS-2 Science Team

+ CIMS Science Team

Aura Science Team Meeting

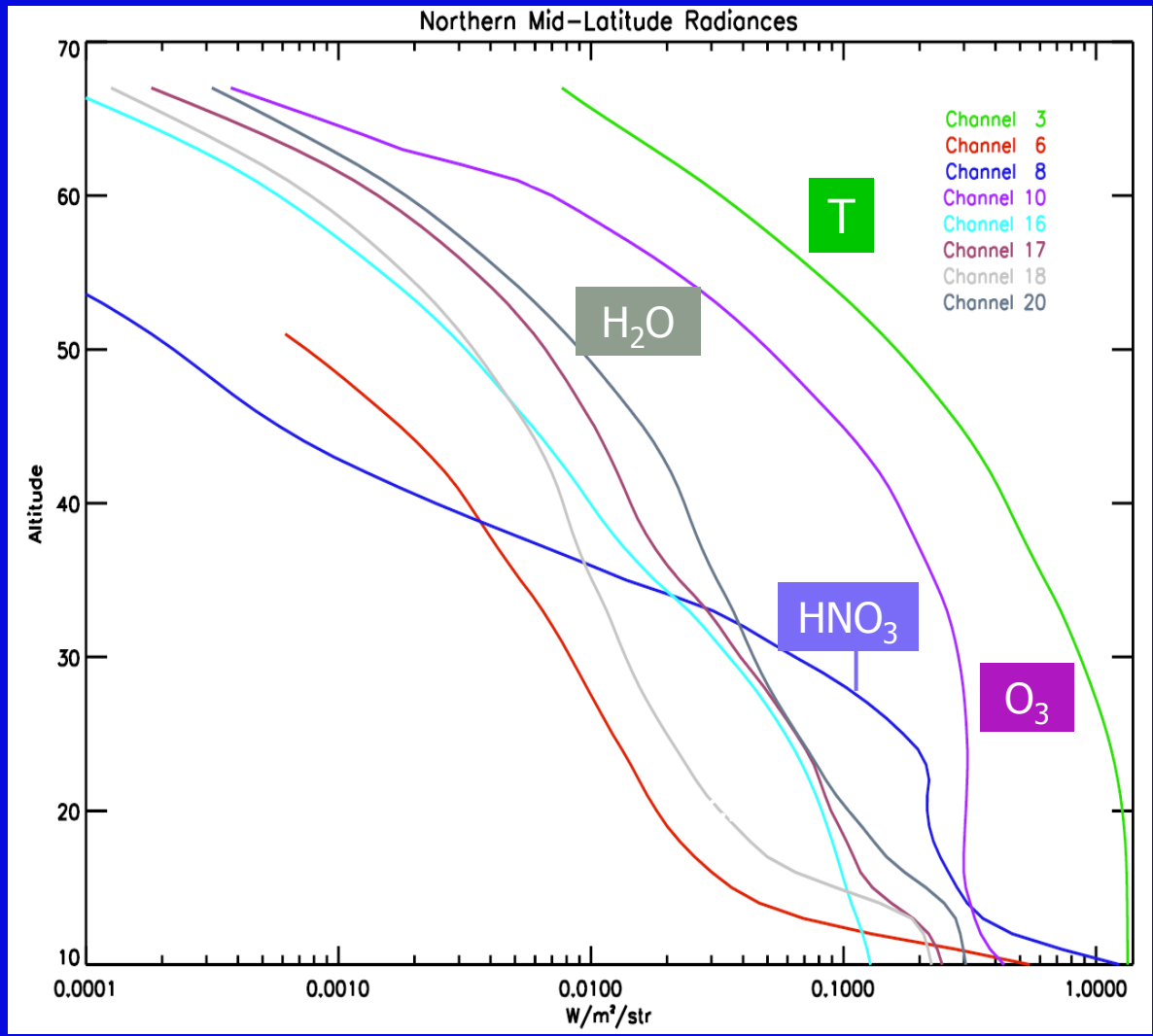
11-15 September 2006

Presentation Outline

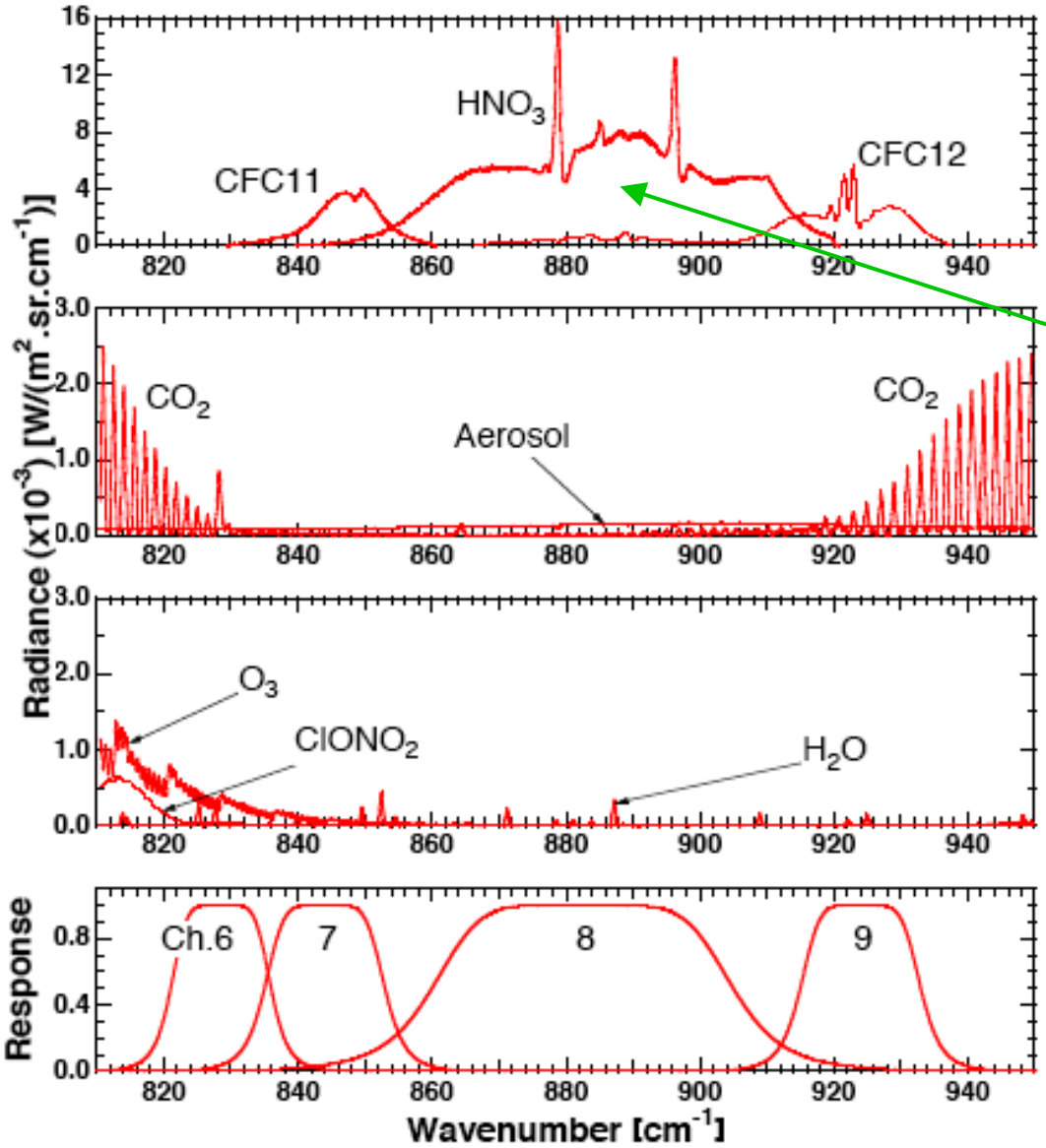
- HIRDLS HNO_3 Signal Characteristics
- HIRDLS HNO_3 Climatological Distributions
- HIRDLS HNO_3 Vertical Range
- HIRDLS HNO_3 Accuracy
  - Compared to ACE
  - Large Balloon (FIRS-2, 2005)
  - PAVE
  - Houston Ave 2005
- Summary and Future Algorithm Development
  - Validation paper?

HNO_3 Channel 8 Radiance Signal is Strong!

- Atmospheric radiances from HIRDLS channels span ~ 4 orders of magnitude
- Initial success for T and O_3 was for channels with largest radiances, most tolerant to correction errors



Limb Radiance Spectra for HIRDLS channels 6-9 for a Tangent Height of 25km



Edwards et al., Appl. Optics, 1995.

HNO_3 has a strong radiance signal in channel 8 between 861-903 cm^{-1}

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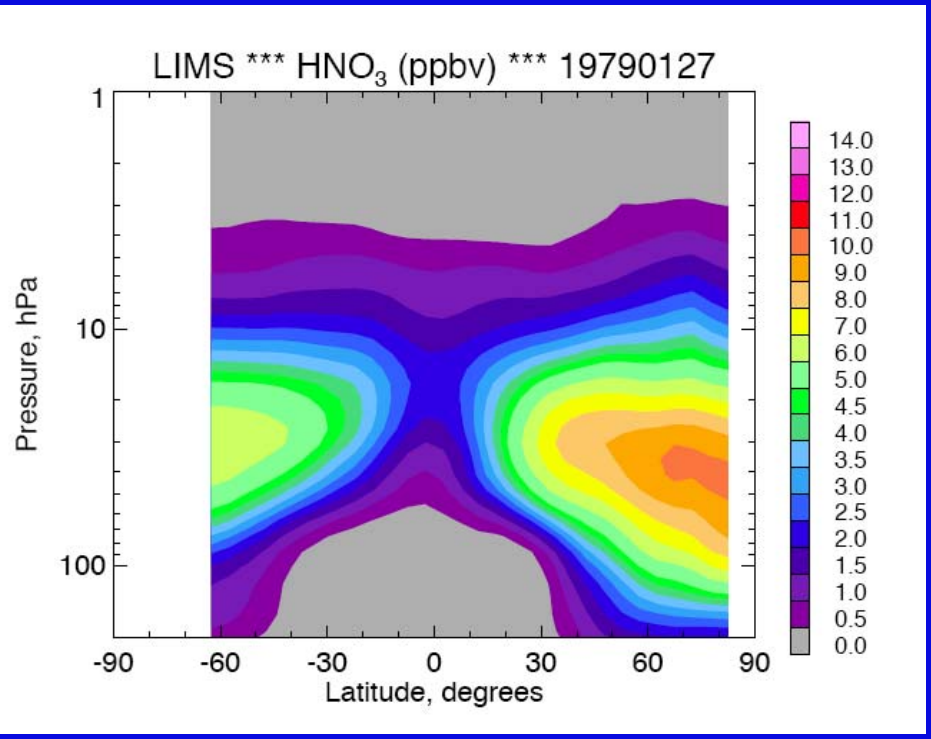
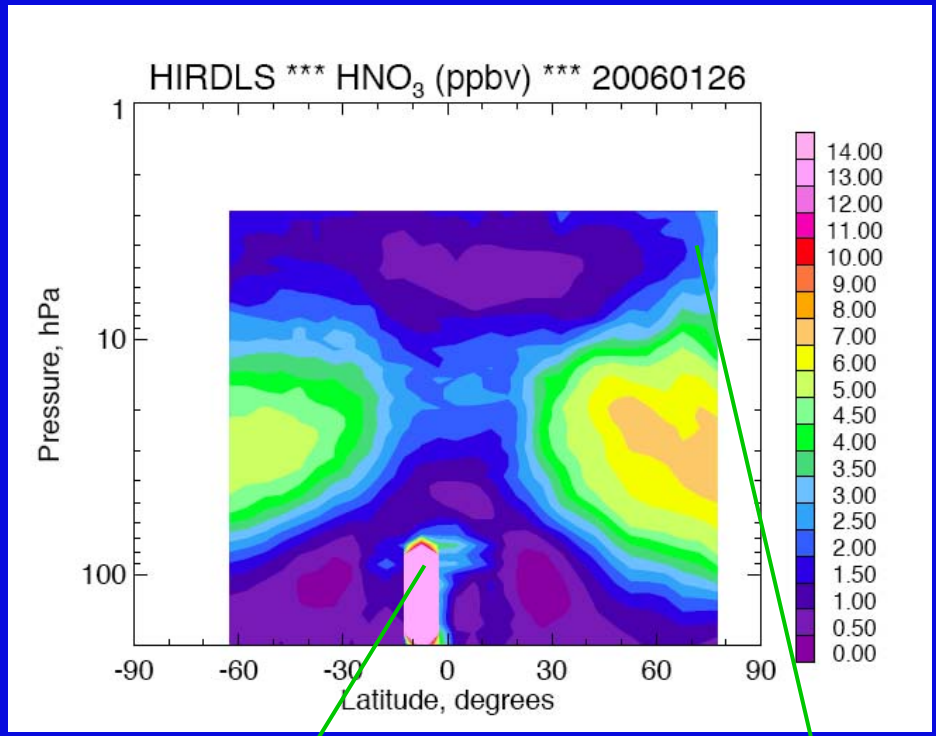
Global Comparisons January (1979; 2006)

binned: 5° latitude; 20° longitude; all profiles





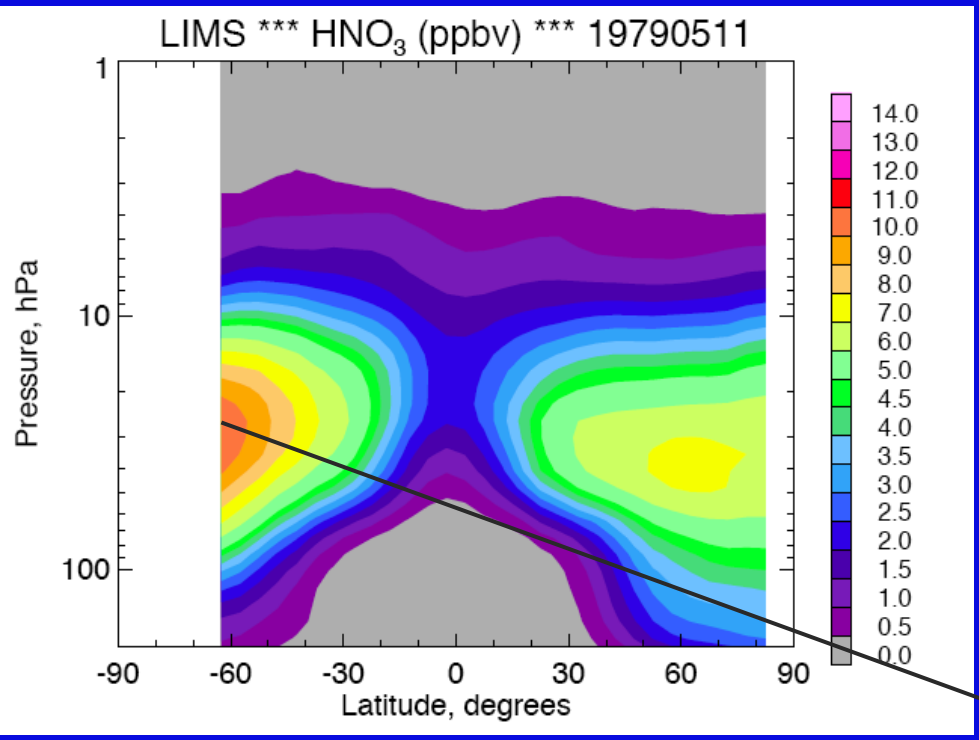
Correct Winter/Summer Asymmetry represented in HIRDLS (more HNO_3 in NH)

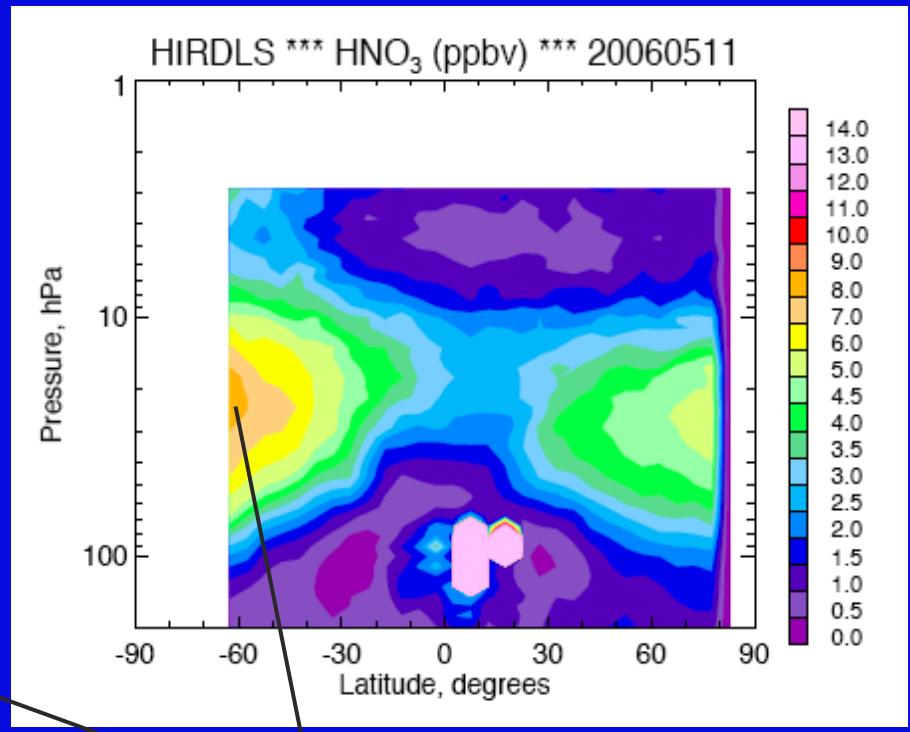
Cloud signatures

Retrieval issues in the upper stratosphere, polar region

Global Comparisons May 11th (1979; 2006)

binned: 5° latitude; 20° longitude; all profiles

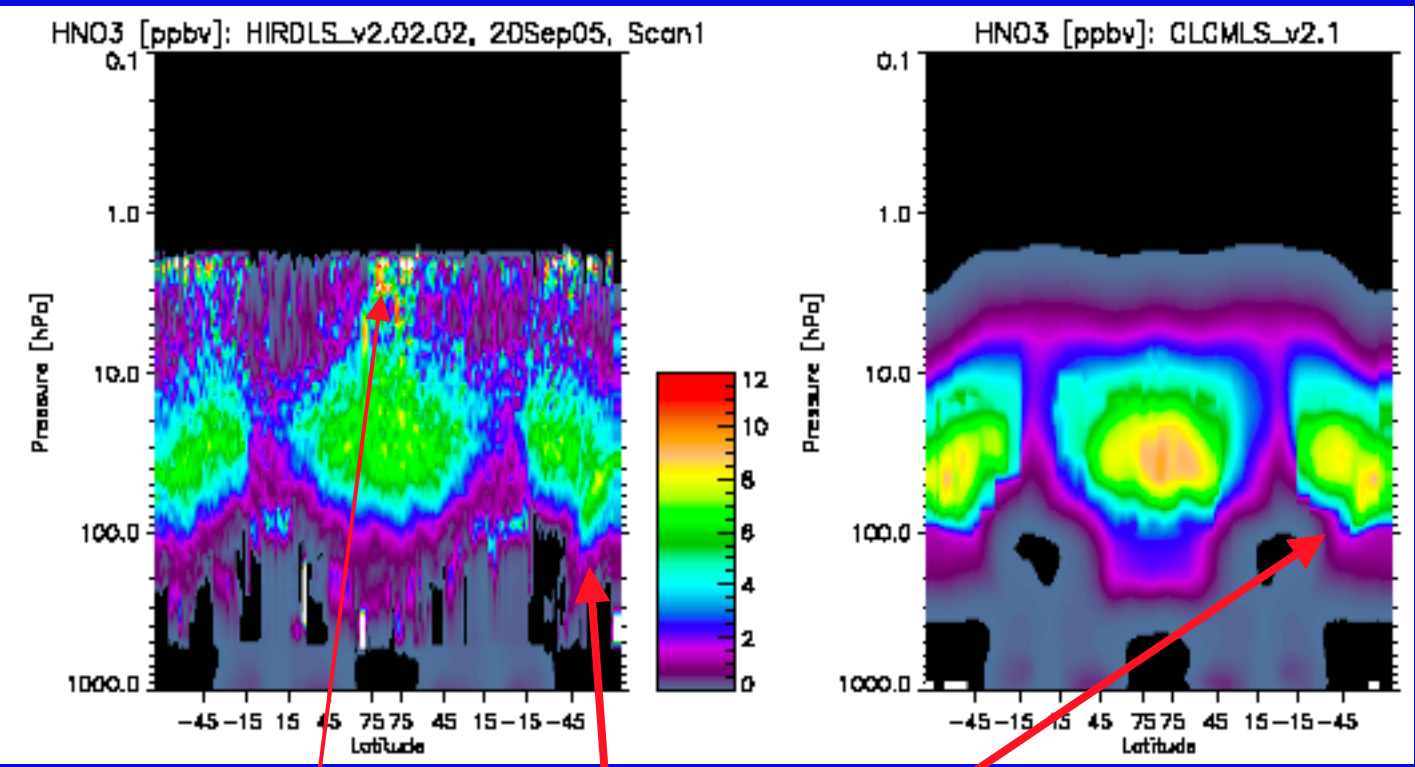




Correct Winter/Summer Asymmetry represented in HIRDLS (more HNO_3 in SH)

HIRDLS VMR peak too high.

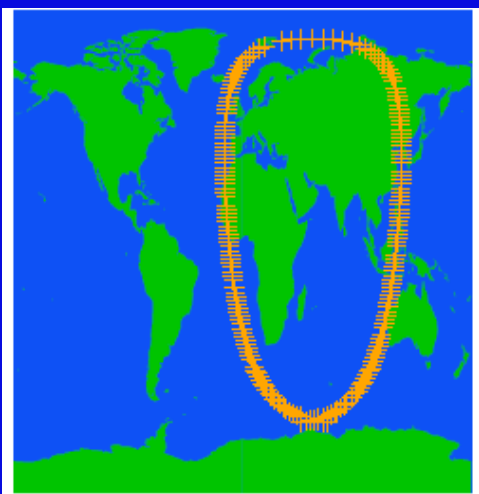
HNO_3 (ppbv) *** Orbit Plot for 2005, September 20



HIRDLS V2.02 vs MLS V2.1

Common Features

More noise in polar high altitude region.



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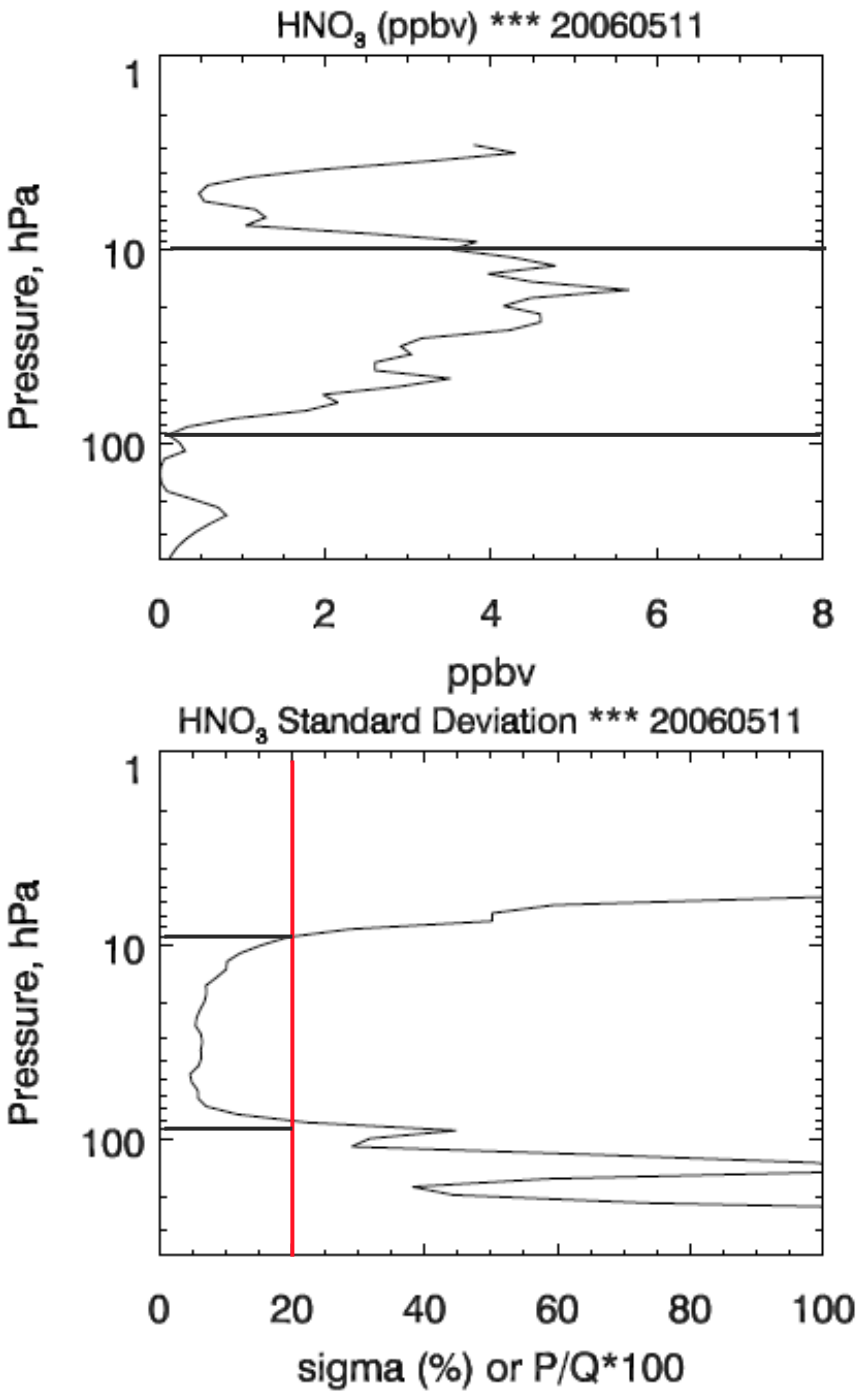
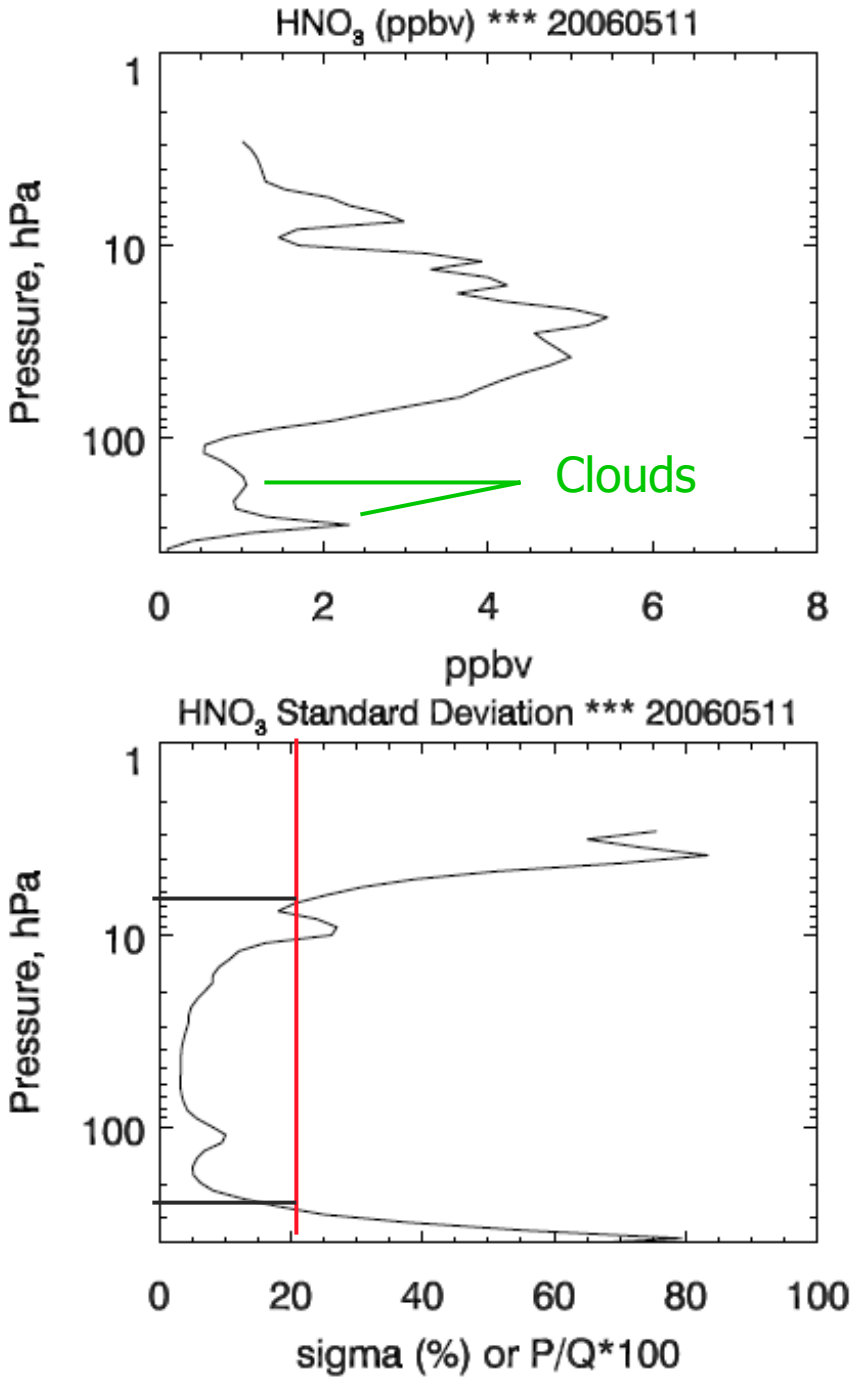


HIRDLS HNO_3 Profile.

Latitude = 31°S
Longitude = 12°W

- σ = Standard deviation of the total error from the diagonal of the error covariance matrices.
- Typically all profiles have a σ = < 20% between 100 hPa and 10 hPa.
- When the variance of the total error increases significantly greater 20-30%, the contribution of the *a priori* increases dramatically.



HIRDLS HNO_3 Profile.

Latitude = 57°N

Longitude = 15°W

Some profiles have a larger range: 6 hPa to 250 hPa.

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Atmospheric Chemistry Experiment

Launched on the Canadian SCISAT-1 satellite on 12 Aug 2003

IR (2.2 – 13.3 μm) Fourier Transform Spectrometer (0.02 cm^{-1} resolution)

Solar Occultation, 74° Inclination:

- **Near global coverage in ~1 month, but extended periods in polar region**
- **Sunrise/Sunset only**

Vertical resolution: ~4 km

Cloud Top to 150 km

(*See GRL special issue, vol. 32, 2005*.)

Courtesy of Cora Randall

HIRDLS vs. ACE Comparisons

HIRDLS data are version 2.02.

ACE data are near-real-time version 2.2.

- Do *not* use High altitude HNO_3 retrievals because there are not enough retrievals at this time.

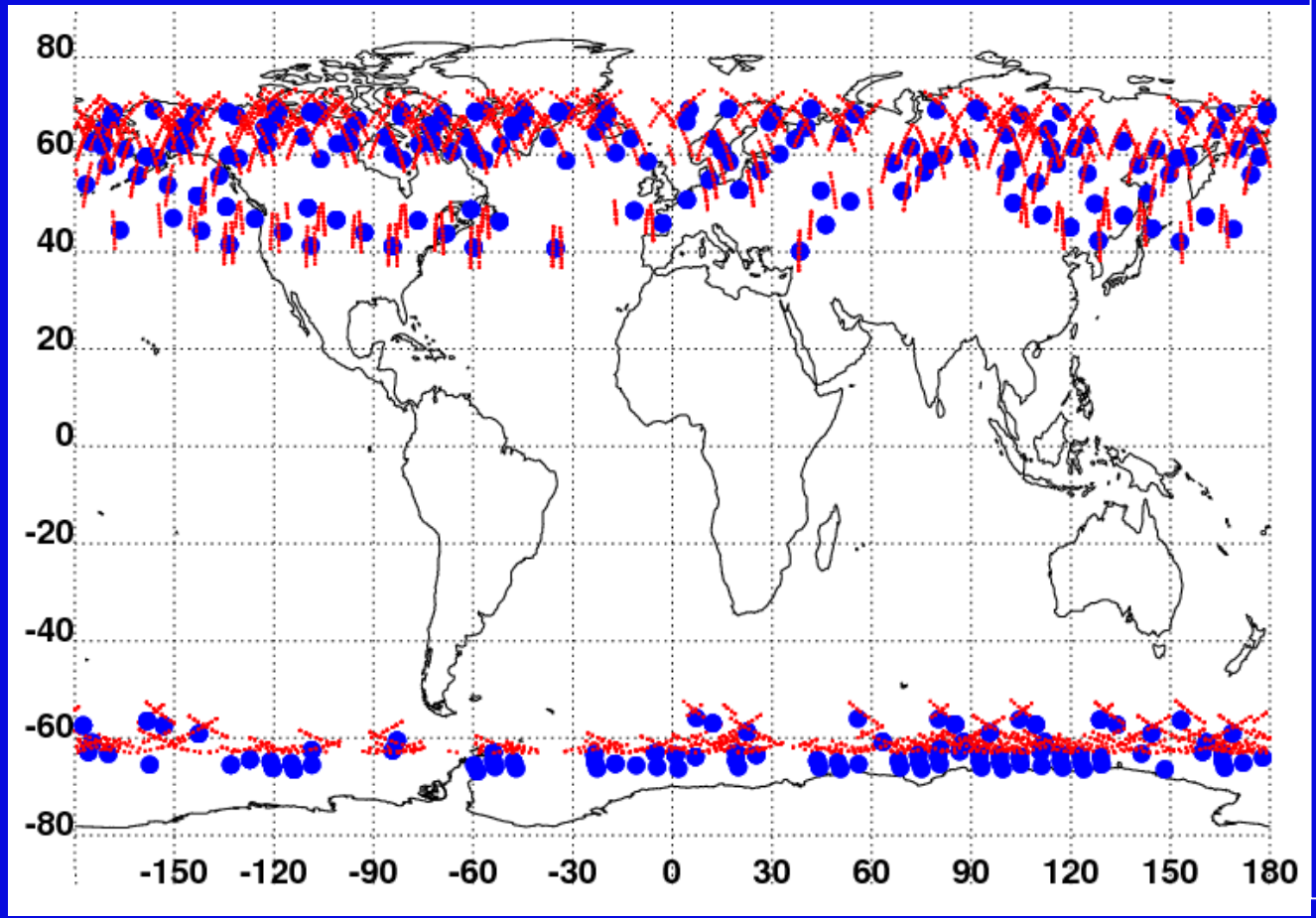
Data Screening

- Omitted HIRDLS data poleward of 63°S.
- Omitted HIRDLS data if precision was negative.
- Omitted ACE data if too large a contribution from a priori.

Coincidence Criteria: Same Day, ± 500 km.

All HIRDLS profiles coincident with a single ACE profile were averaged together before comparing.

HIRDLS/ACE Coincidences in May 2006



Total of 409 coincidences

262 in NH
147 in SH

Avg Separation = 170 km, ranging from 7-470 km

NH ACE:
- 4-22 May Local SR
- 25-31 May Local SS

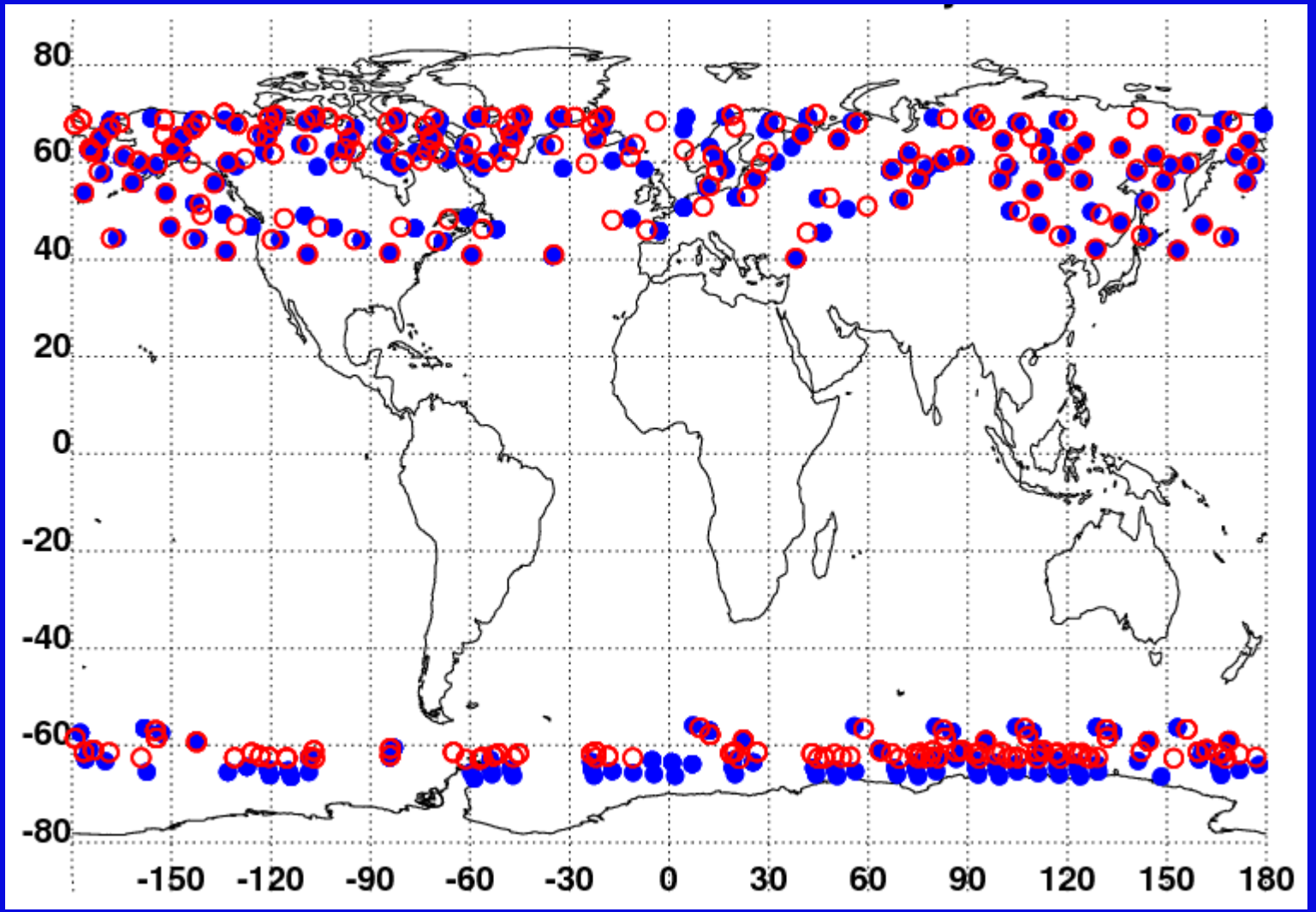
NH HIRDLS:
- 4-22 May ~5 hrs before to 20 hrs after ACE
- 25-31 May 5-15 hrs before ACE

SH ACE:
- Local SS for all coincidences

SH HIRDLS:
- ~5 hours later than ACE

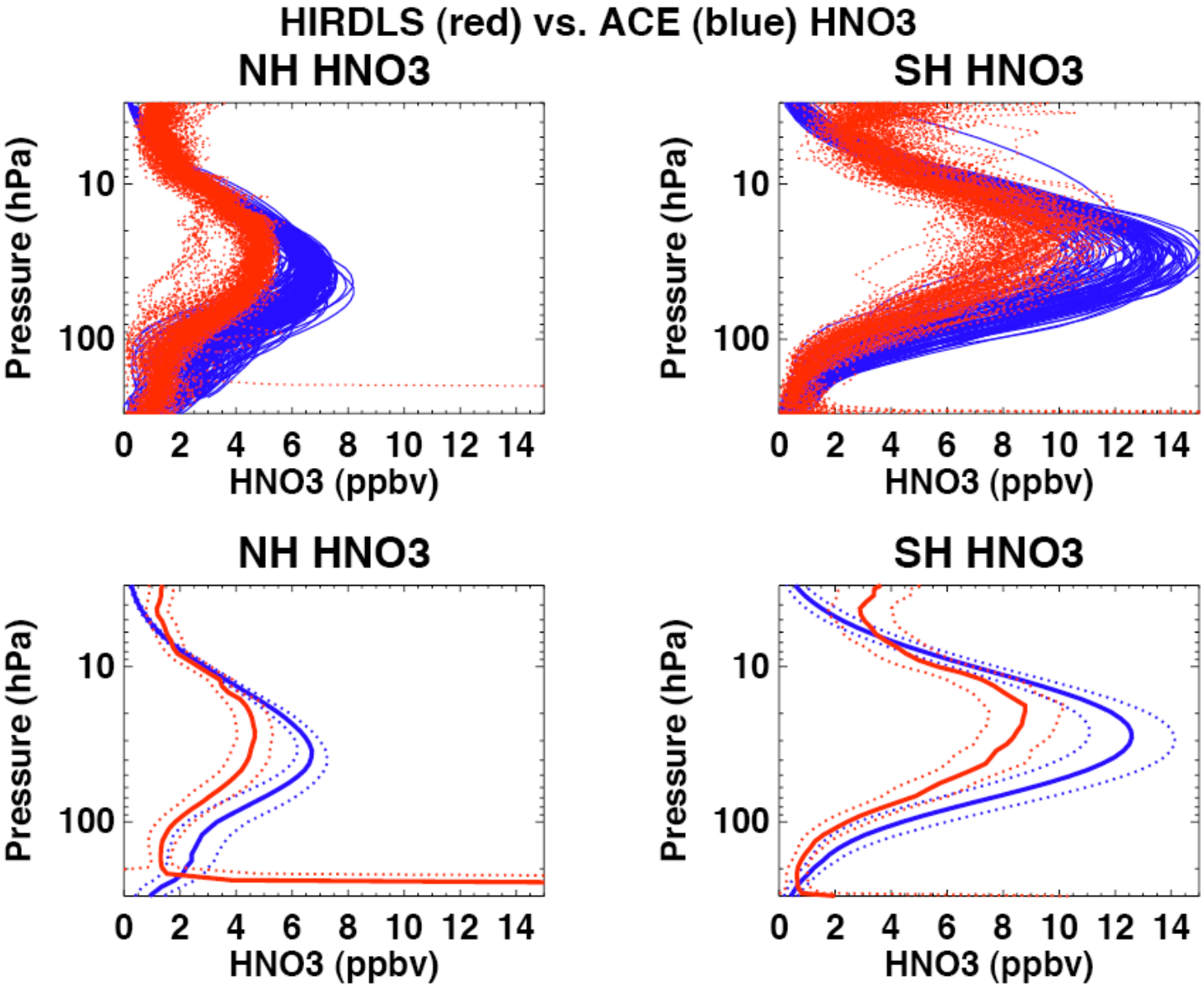
Courtesy of Cora Randall

HIRDLS/ACE Coincidences in May 2006



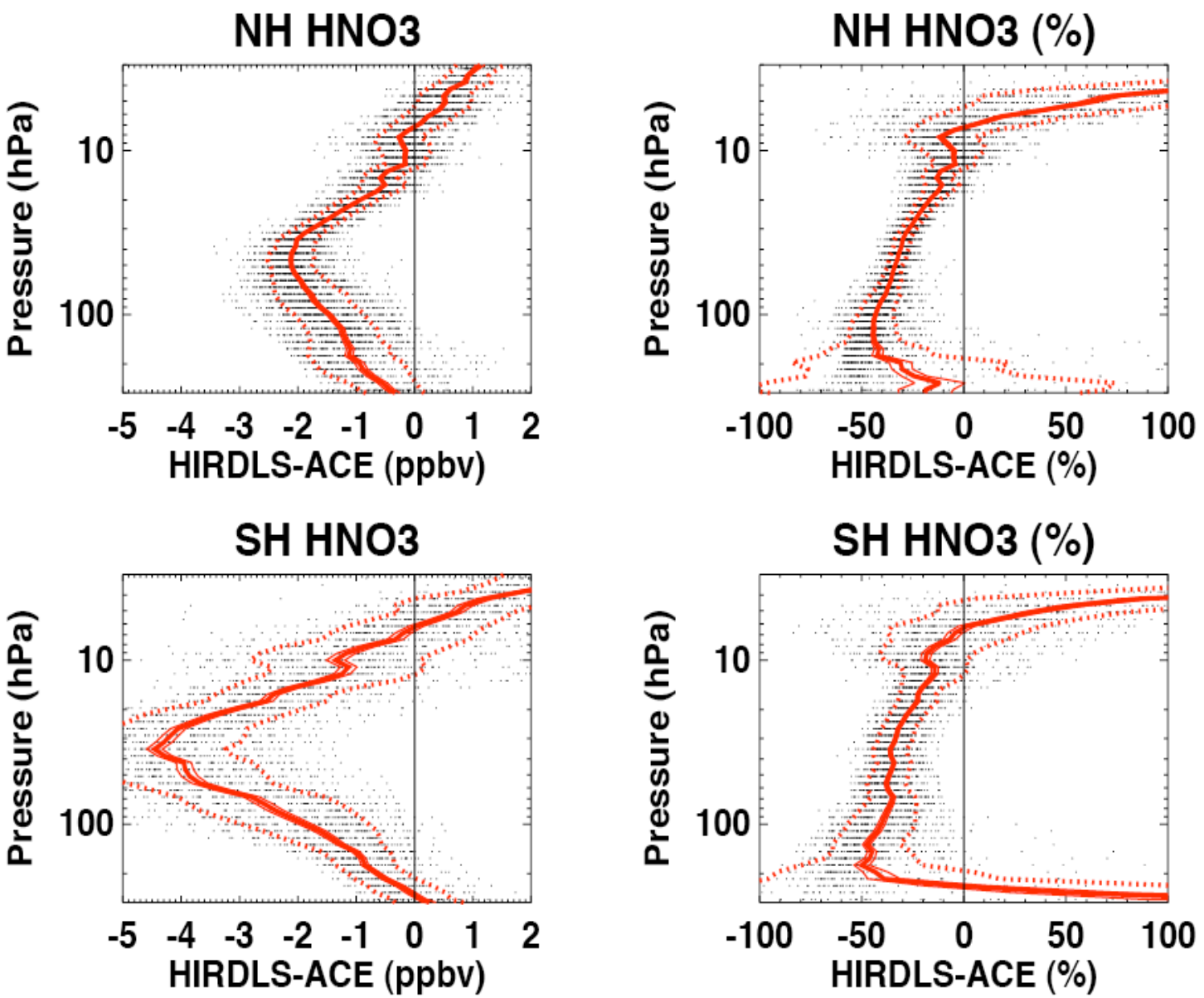
Similar to map on previous slide, but this shows the average location for all HIRDLS profiles (often ~10) coincident with a single ACE profile.

HIRDLS vs ACE



Courtesy of Cora Randall

HIRDLS vs ACE

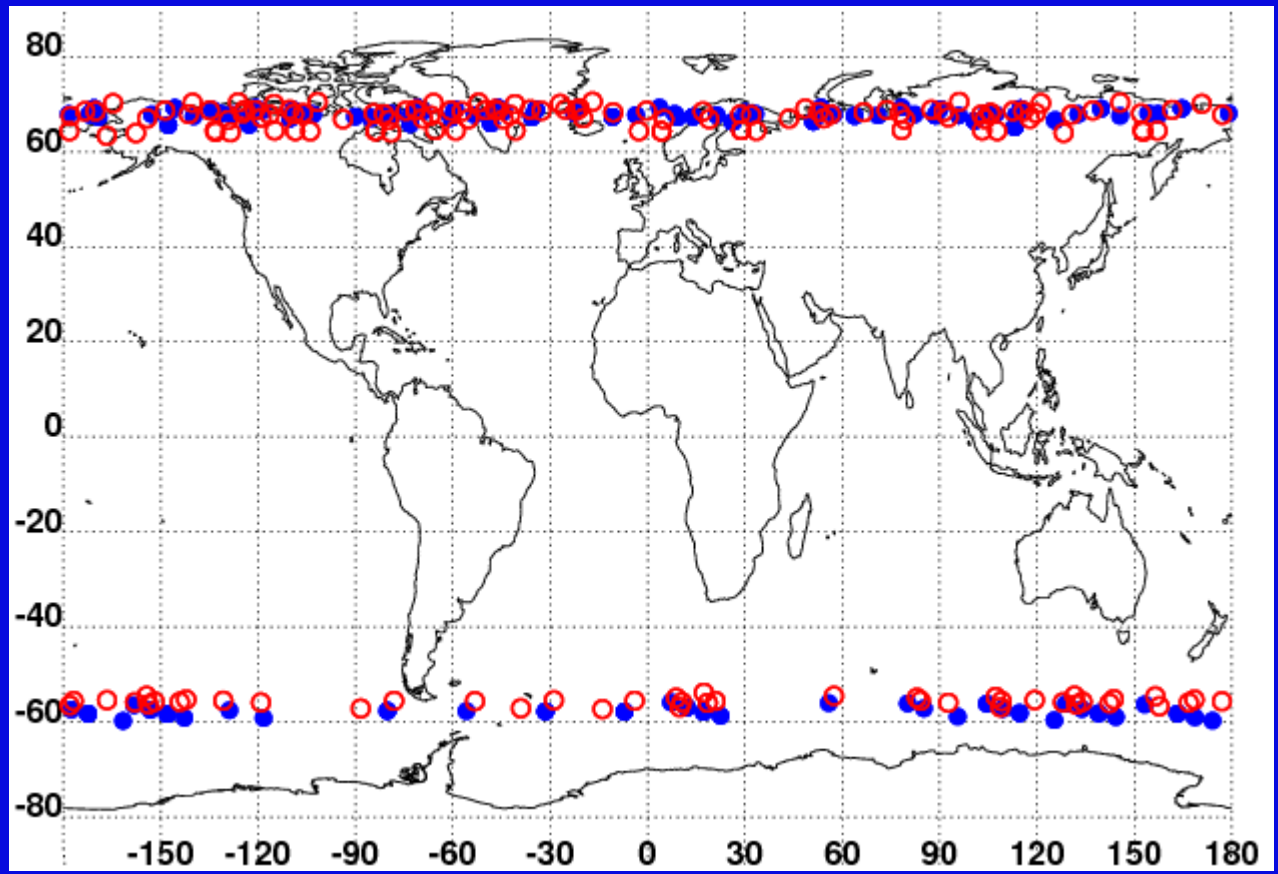


Courtesy of Cora Randall

Coincidence Criteria: ±2 hrs, ± 500 km.

All HIRDLS profiles coincident with a single ACE profile were averaged together before comparing.

HIRDLS/ACE Coincidences, 18-31 May & 11-13 Jul, 2006



Total of 156 coincidences

18-31 May 2006
11-13 July 2006

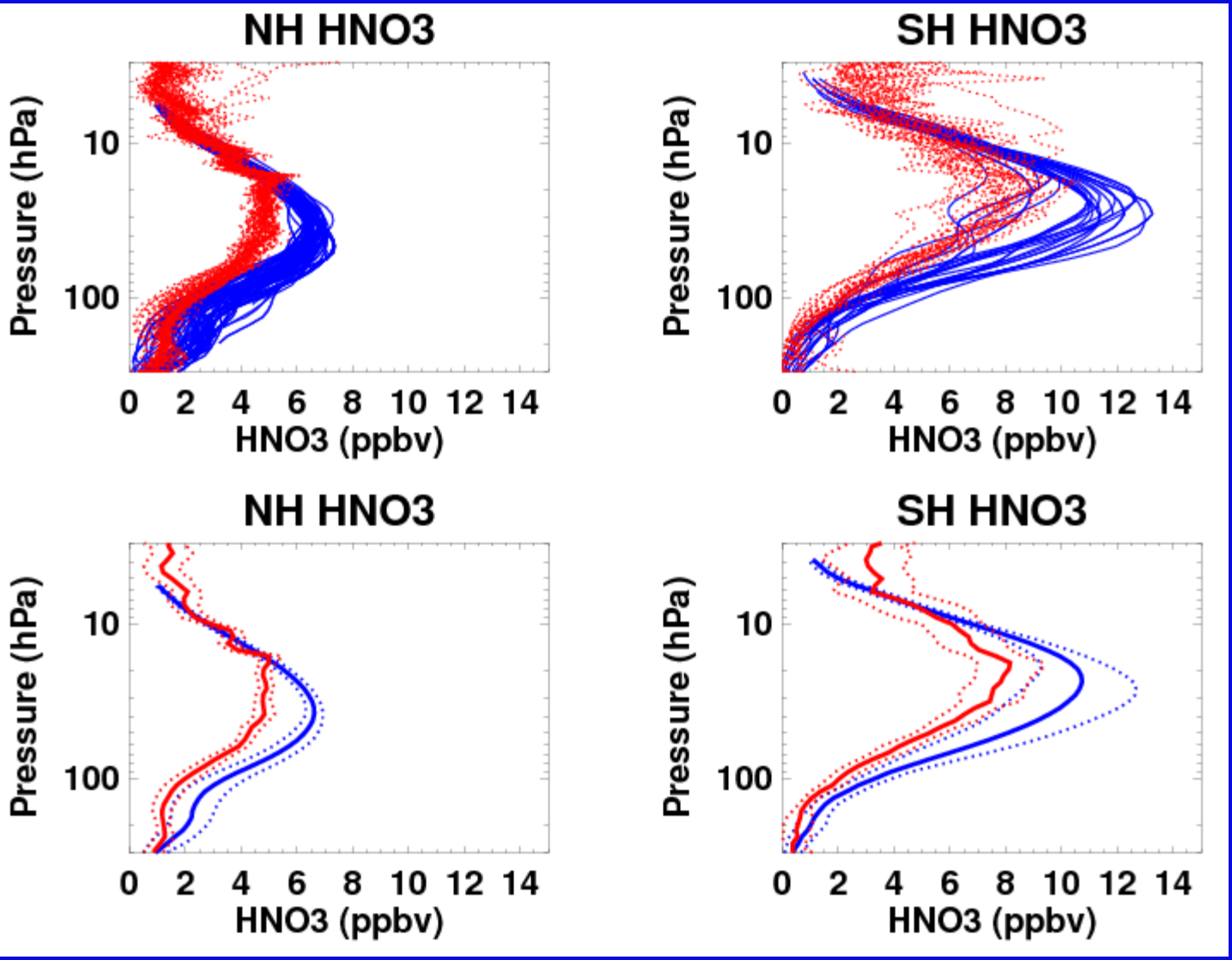
113 in NH
43 in SH

Avg Separation = 302 km, ranging from 37-495 km

Avg Time Diff = 1.1 hrs

Courtesy of Cora Randall

HIRDLS & ACE Nitric Acid Profiles

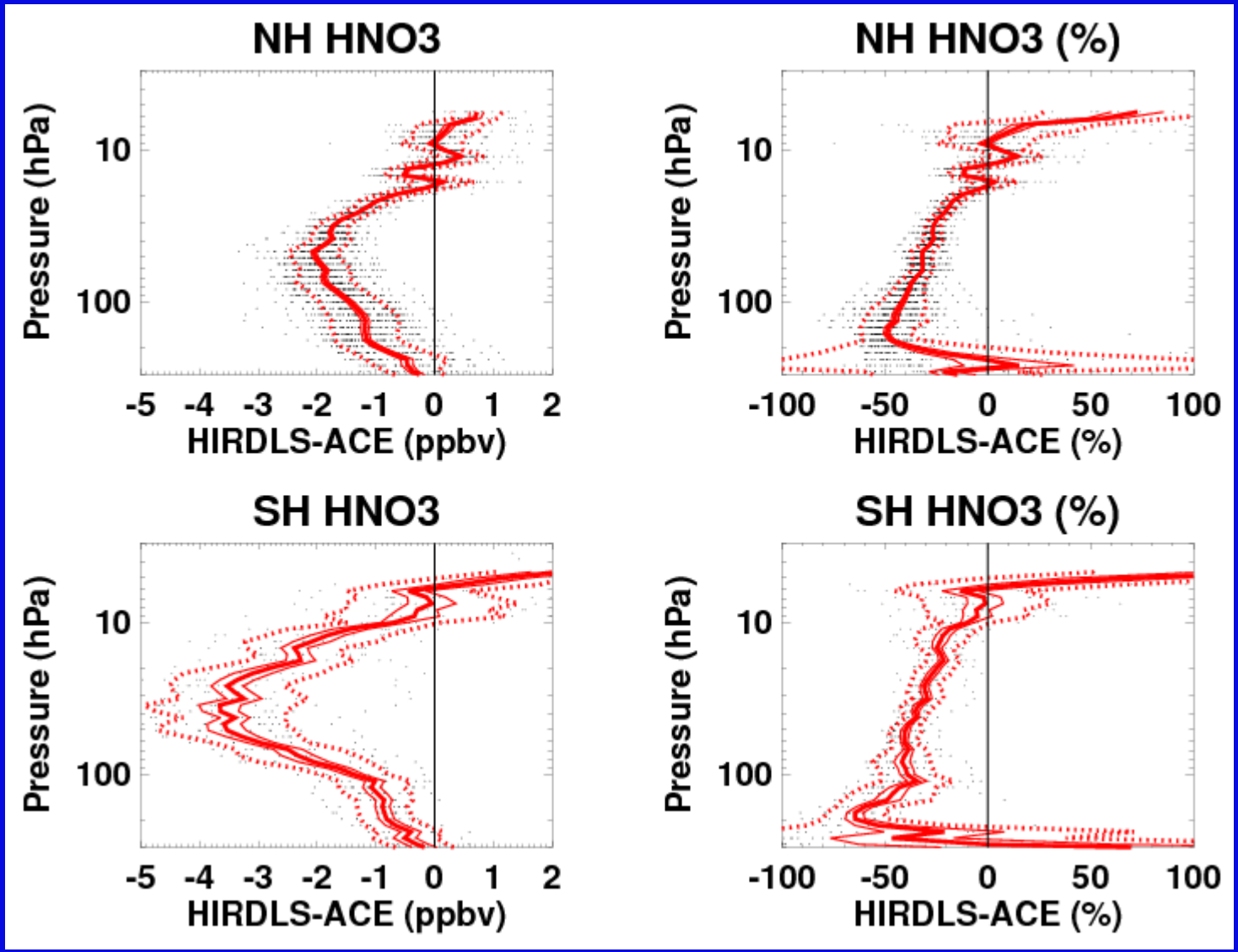


All Coincidences

Average (solid) & 1-σ standard deviation (dotted)

Courtesy of Cora Randall

HIRDLS-ACE Nitric Acid Differences



Thick red:
Average

Dotted red:
1-σ distribution

Thin red:
1-σ uncertainty (often hidden)

Black points:
Individual differences

Courtesy of Cora Randall

Far-Infrared Spectrometer (FIRS-2)

Launched in New Mexico, Ft. Sumners.

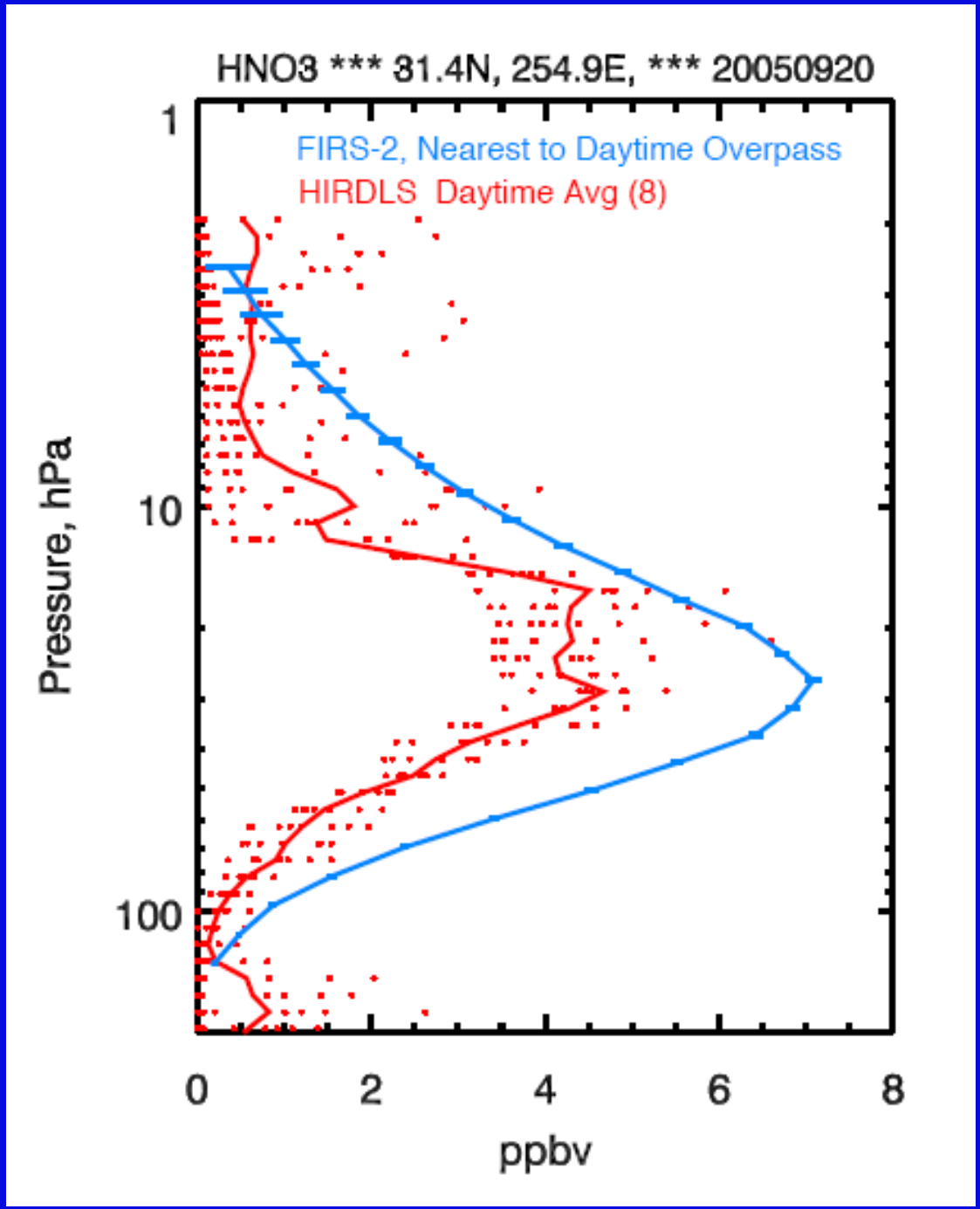
High Resolution Fourier Transform Spectrometer (0.004 cm^{-1} resolution)

Measures thermal emissions of atmosphere from balloon.

Vertical resolution: 3-4 km

Cloud Top to approx 40km (3 hPa)

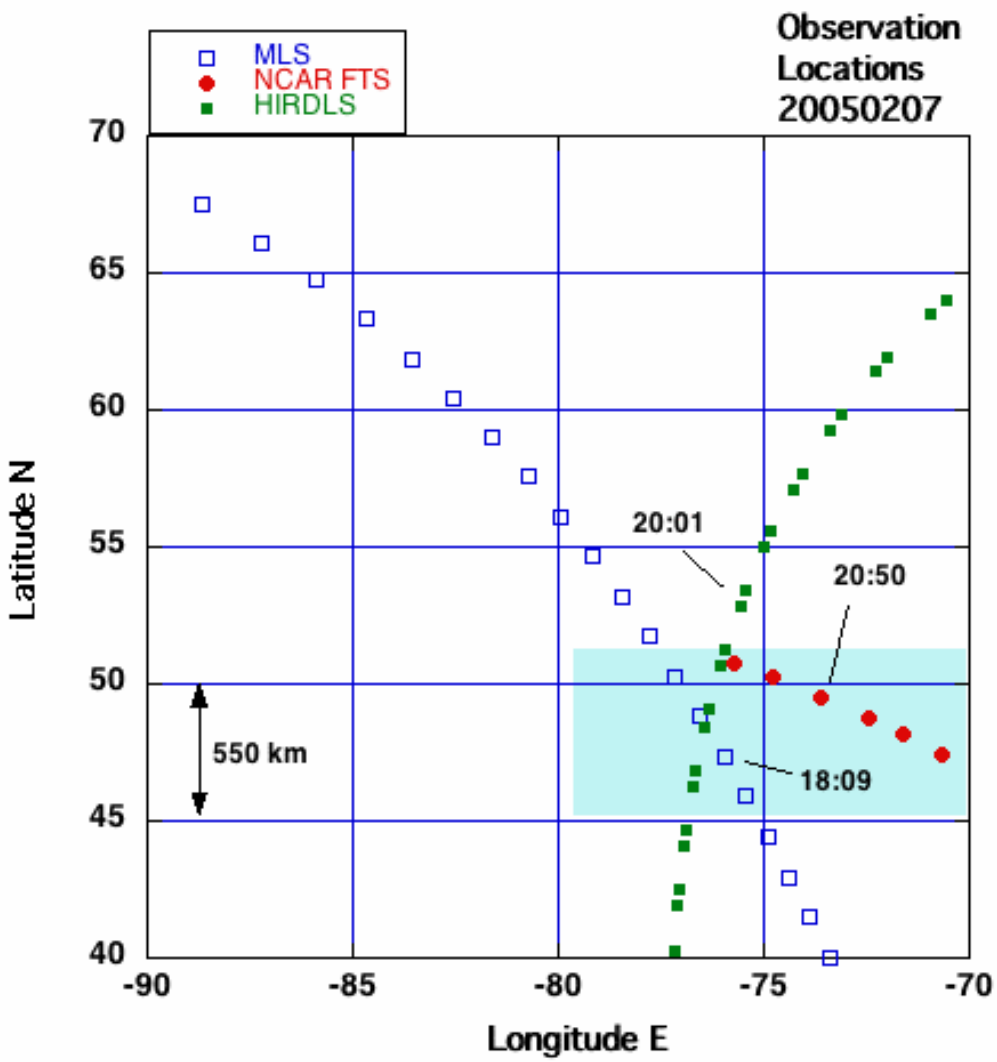
(See Jucks et al., 1998; …)



HIRDLS vs FIRS-2

- September 20, 2005
  - 31.4 N latitude
  - 255 E longitude.
- Coincidence is within 5° longitude and 2° latitude.
- 8 HIRDLS profiles
- Daytime overpasses for HIRDLS
- Used the FIRS-2 profile that was nearest to the Aura overpass.
- Preliminary FIRS-2 data (Ken Jucks).

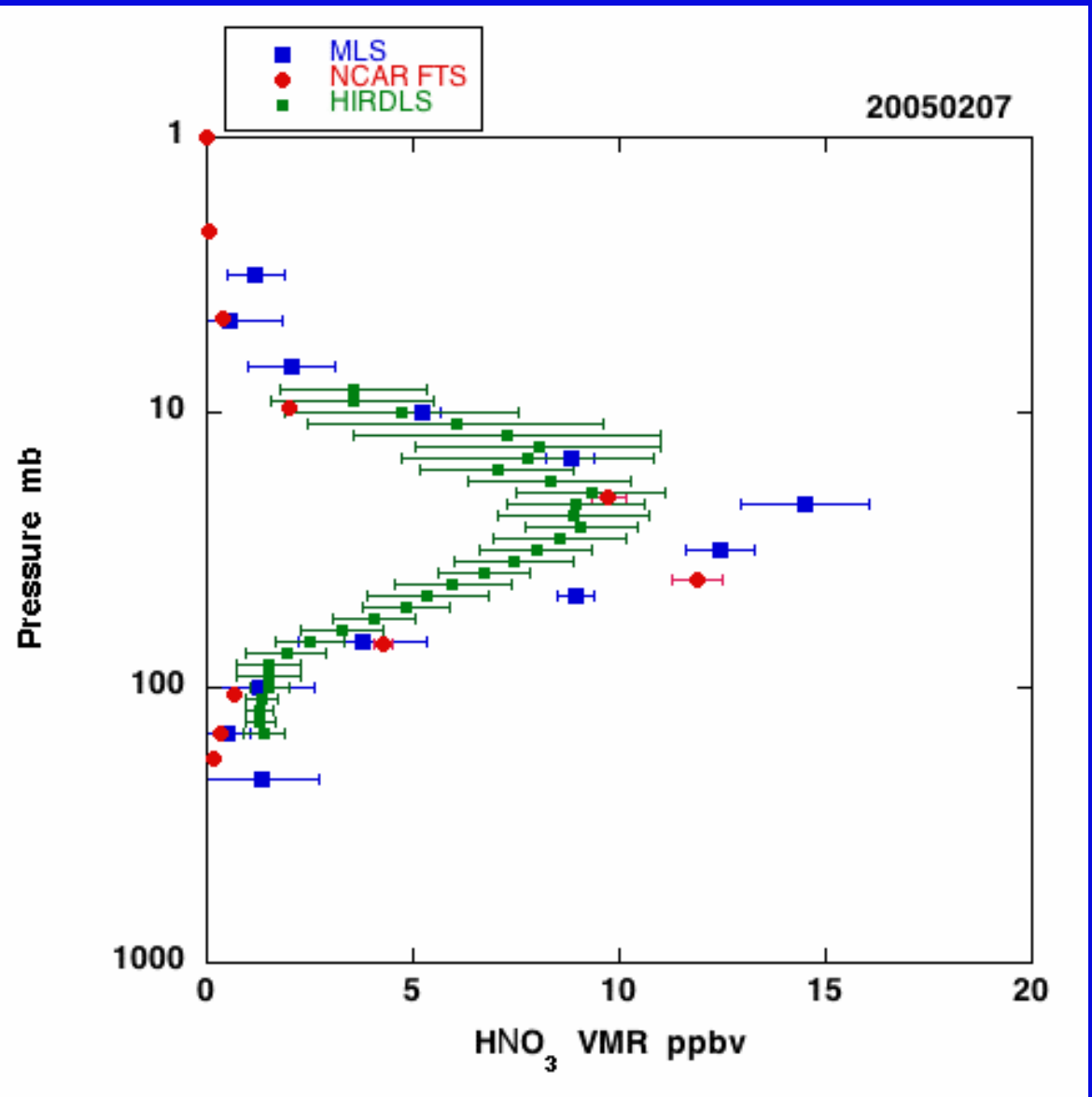
HIRDLS vs NCAR FTS (See M. Coffey's Poster)



- PAVE February 7, 2005
- Comparisons are made outside of the vortex on this day.

Courtesy of Mike Coffey

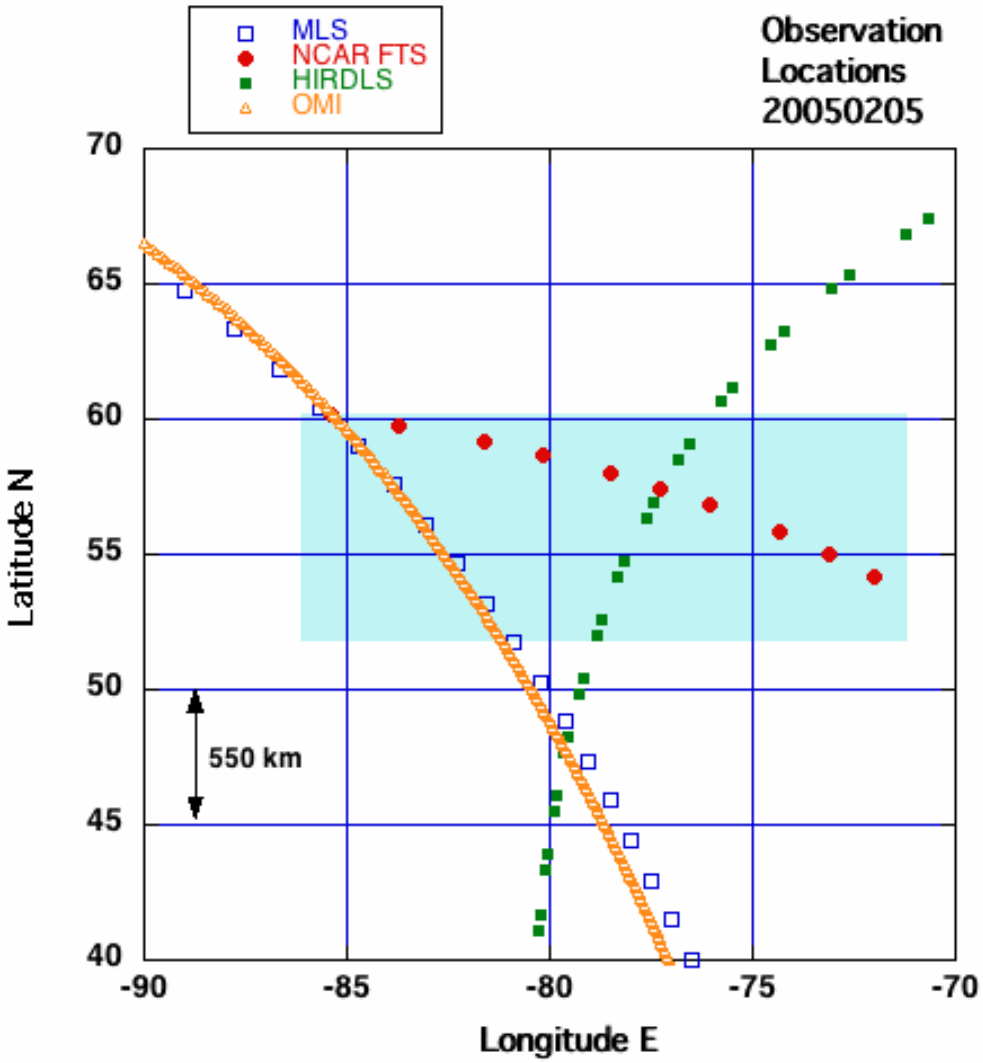
HIRDLS vs MLS and NCAR FTS



- PAVE February 7, 2005
- MLS V1.5

Courtesy of Mike Coffey

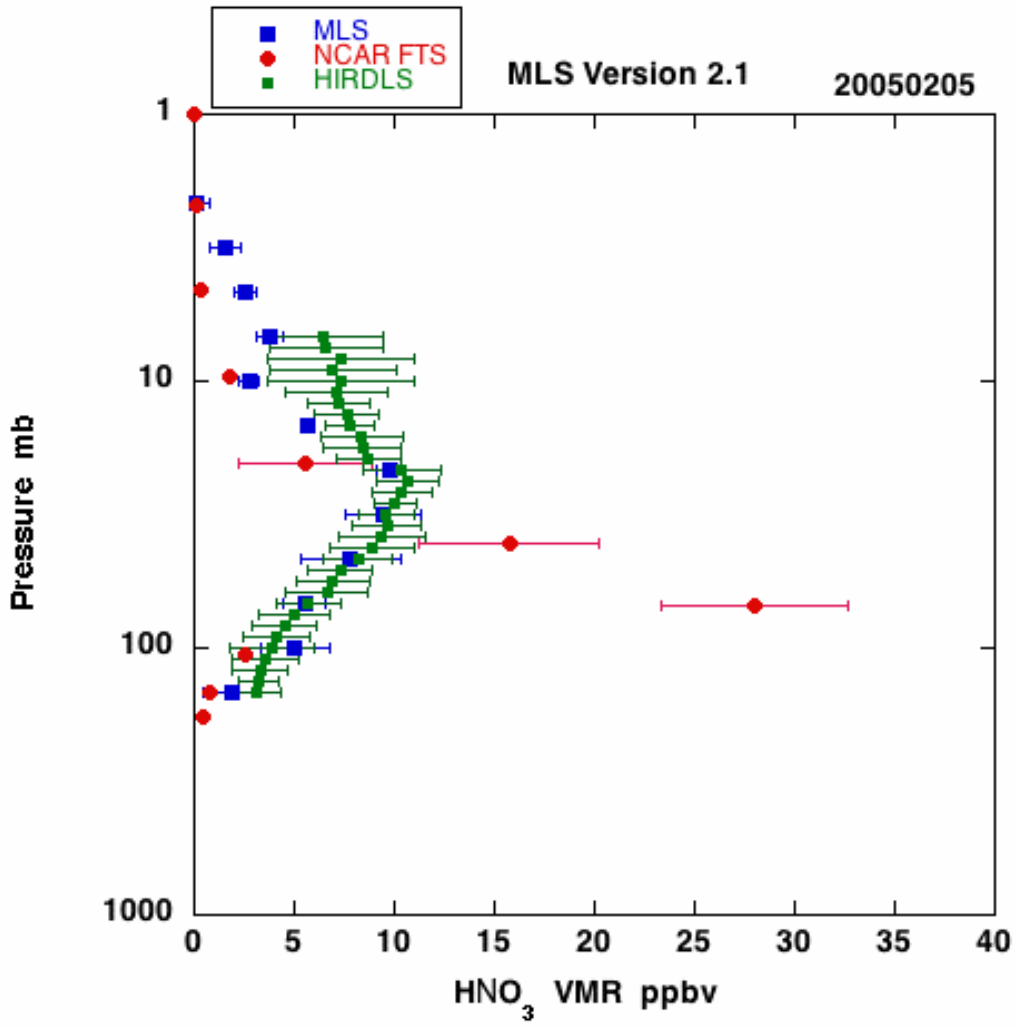
HIRDLS vs NCAR FTS (See M. Coffey's Poster)



- PAVE February 5, 2005
- MLS V2.1 data

Courtesy of Mike Coffey

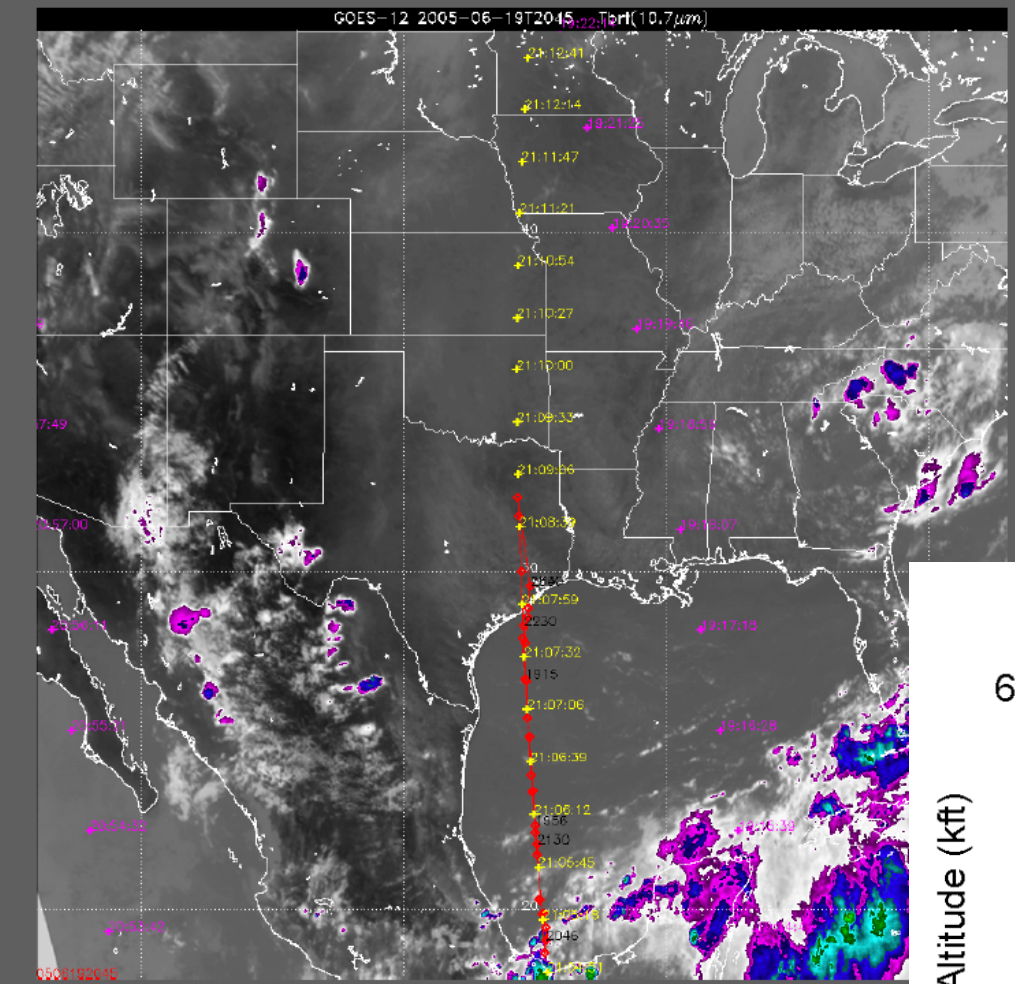
HIRDLS vs MLS and NCAR FTS



- PAVE February 5, 2005
- MLS V2.1 data

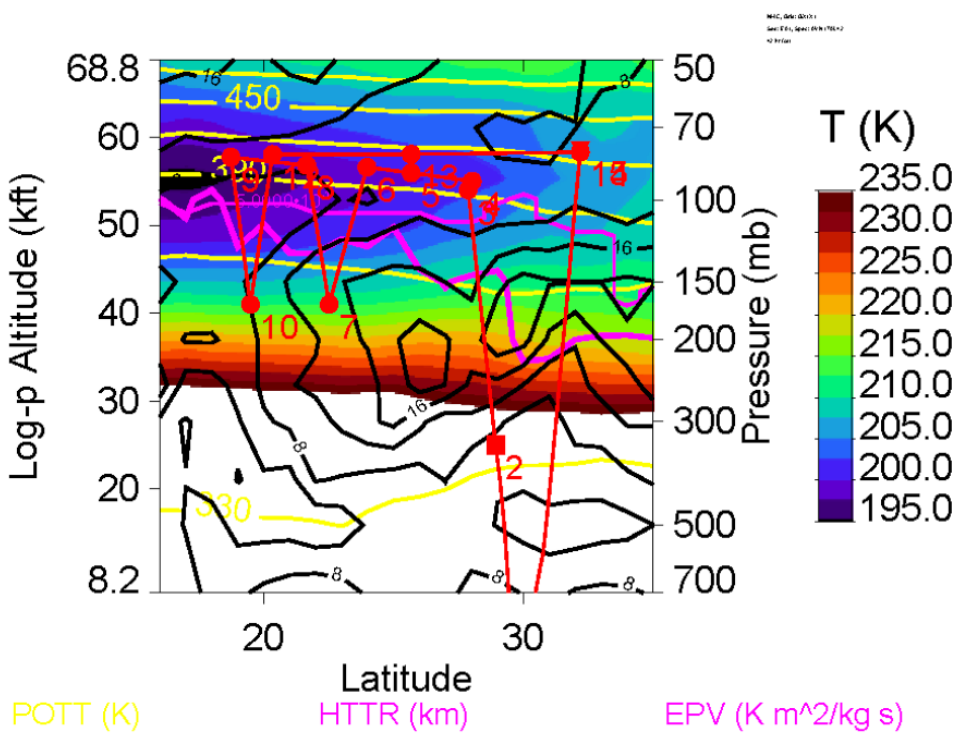
Courtesy of Mike Coffey

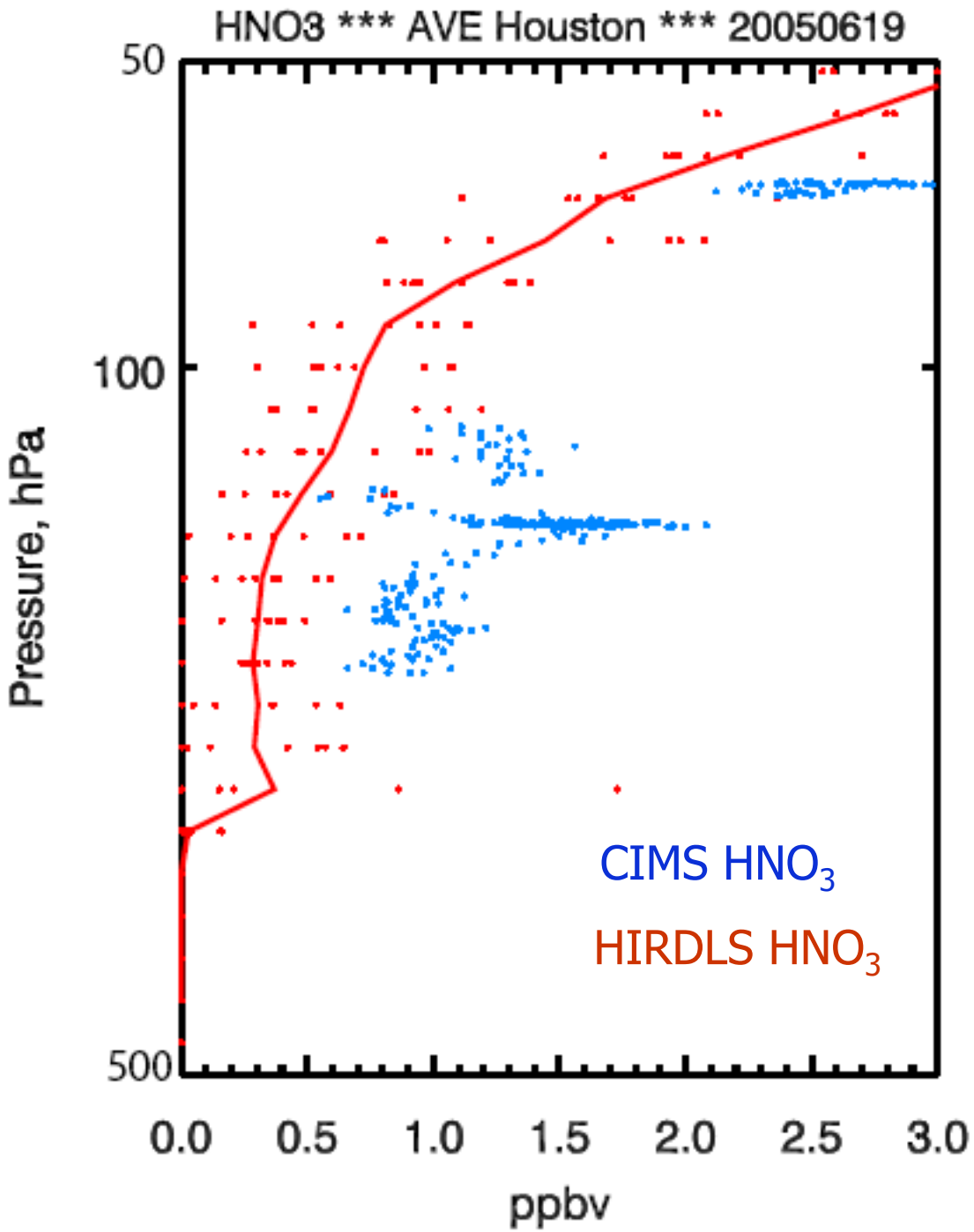
[2] 2005/06/19 flight track superimposed on GOES-12 IR image



Houston AVE 2005 CIMS comparison

- June 19, 2005





HIRDLS vs CIMS

- Houston AVE, June 19th 2005.
- HIRDLS profiles between 28-34°N (8-total).
- CIMS data during descent. Downward facing inlet.
- HIRDLS agrees with CIMS within a factor of two.

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HNO_3 Summary…

- Morphology consistent with MLS and ACE
  - Orbit plot comparison between HIRDLS and MLS show similar structure.
  - High latitudes have correct hemispherical asymmetry.
  - Peak HNO_3 is (near) the right altitude.

- Vertical range of HNO_3 product is between 100 hPa 10 hPa
  - In some instances the range can be extended downward to approximately 200 hPa and upward to 3 hPa.

- HIRDLS Biased low relative to ACE, FIRS-2, FTS, CIMS
  - Biased low in the middle stratosphere (50%, 2-3 ppbv)
  - Biased high in the upper stratosphere (50%, 1-2 ppbv)
  - Larger bias in the SH vs NH.
  - Within a factor of two in the UTLS region.

- Overall HNO_3 product has improved greatly since September 2005.

The END